

The coal gas story

United Kingdom suicide rates, 1960-71

NORMAN KREITMAN

MRC Unit for Epidemiological Studies in Psychiatry, University Department of Psychiatry, Royal Edinburgh Hospital, Edinburgh

Kreitman, N. (1976). *British Journal of Preventive and Social Medicine*, **30**, 86-93. **The coal gas story: United Kingdom suicide rates, 1960-71.** A detailed analysis of suicide rates between 1960 and 1971 for England and Wales and for Scotland confirms that all age-sex subgroups have shown a marked decline in suicide due to domestic gas, corresponding in time to the fall in the CO content. After considering data on the effects of the *International Classification of Diseases (ICD) Eighth Revision*, accident mortality, some personal characteristics of coal gas suicides, and the use of coal gas in parasuicide it was concluded that a simple causal explanation was likely. Suicide due to non-gas methods has in general increased, markedly so in some groups. It was suggested that neither improved psychiatric services nor voluntary agencies could have produced such changes. The 'compensatory' trend of gas and non-gas suicide rates was indicated for certain age-sex subgroups. The continuing need for suicide research was pointed out, and questions were raised concerning the psychological meaning of the epidemiological data.

During the 1960s in the United Kingdom a striking change was witnessed in suicide mortality both in numbers and in the methods employed. This paper explores some of these developments with particular reference to suicide caused by domestic gas and its relationship to other modes of suicidal death, and attention is drawn to some implications and problems, both epidemiological and psychological, that emerge from an overview of the data.

Most, although not all, of the data to be employed were derived from official publications, with those from England and Wales being considered separately from Scottish figures. The pattern of reported suicide rates by age differs in the two regions, especially for men (Kreitman, 1972; Ross and Kreitman, 1975) and this difference in profile, which was particularly clear at the beginning of the decade, provides a useful means of checking the importance and consistency of any secular trends judged likely to affect the United Kingdom as a whole.

It will be convenient first to look at the general pattern of suicide mortality during the period and then to consider the changes that have occurred in domestic gas supplies and in suicides caused by gas poisonings.

THE GENERAL PATTERN

Inspection of the Registrar General's reports shows that from about the end of the second world war the crude suicide rates for both sexes in both areas (England and Wales, and Scotland) displayed an increase which continued until the early 1960s. The rate of climb differed somewhat by sex and country, with Scottish men increasing most rapidly and men in England and Wales showing little change. After 1962 or 1963 there was a general decline, although not one of uniform magnitude for all categories; Scottish women, for example, showed only a very slight fall. Figs 1 and 2 show these trends up to 1971, the latest year for which data were available at the time of writing.

The causes of the initial phase—the familiar postwar rise in suicide rates—are fortunately not at issue here. Such trends are well documented (if little researched) and the point at issue is only that for at least three of the four groups (Figs 1 and 2) the rates were still rising at the beginning of the 1960s. Some flattening out might have been anticipated, but the change which ensued was a decline. It is not without irony that, apart from the pioneer work of Sainsbury, the climbing suicide rate went largely unremarked in the British literature, while the subsequent improvement has produced vigorous

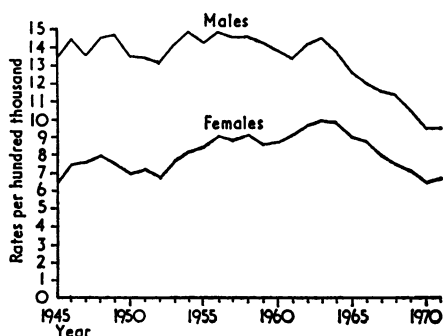


FIG. 1. Sex-specific suicide rates: England and Wales 1945-71.

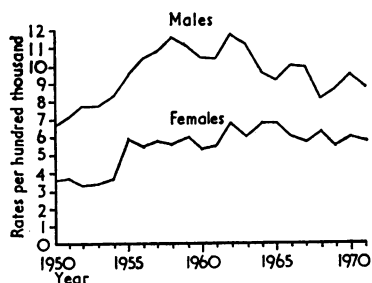


FIG. 2. Sex-specific suicide rates: Scotland 1950-71 (1945-49 were very erratic and have been omitted).

comment. Claims for the decline have been made on behalf of the Telephone Samaritans (Bagley, 1968, 1971, 1972; Fox, 1975), the improved medical cover available under the National Health Service (Barracrough, 1972), and the effect of reducing the carbon monoxide content of domestic gas (Hassall and Trethowan, 1972), the last report triggering off a minor polemic (Malleon, 1973a, b; Bagley, 1973).

CHANGES IN DOMESTIC GAS SUPPLIES

The nationalization of the gas industry in 1948 occurred at a time when each regional gas company manufactured its own supplies, with no responsibility for neighbouring areas. Gas was then produced almost entirely from coal ('town gas') and contained between 10% and 20% carbon monoxide: the modal value for a gasworks was around 14%.

In the early 1950s a method of manufacturing gas from oil products and naphtha began to be used. This yielded a product miscible with coal-based gas, but containing a proportion of carbon monoxide, which although high initially, was rapidly reduced to only 1.1%. The proportion of oil-based gas in domestic supplies rose from about 7% in 1955 to

64% in 1969, although again these figures reflect the national picture without taking account of any variation between local gas systems*.

The last change was the introduction of natural gas, beginning in 1958 and gaining in tempo steadily thereafter: it is virtually free of carbon monoxide. Since its combustion properties are incompatible with those of coal- or oil-based gas, it has been introduced region by region as adjustments are completed to household appliances. By 1971, 69% of the gas supplied to domestic consumers was natural gas.

Given the proportions of the three types of gas supplied to the nation since 1955 and knowing the carbon monoxide (CO) content of each variety, as produced at a 'typical gasworks' in the case of coal and oil-based gases, it is possible to calculate approximately the CO content of the supplies reaching the average household. The results are shown in Fig. 3. They show an initial decline between 1957 and 1962, followed by a much steeper fall.

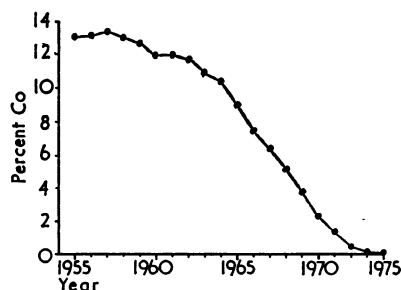


FIG. 3. Percentage of CO in domestic gas, United Kingdom 1955-74.

DOMESTIC GAS AND OTHER MODES OF DEATH IN SUICIDE

ENGLAND AND WALES

The rates for suicides in England and Wales have been divided into that part of the rate attributable to domestic gas and that due to other causes. Since the lethal agent in domestic gas is carbon monoxide it is convenient to refer to the former simply as CO suicides. Fig. 4 shows for each sex the crude rates for each type of suicide since 1955. They have clearly diverged. Nevertheless, a more detailed analysis seemed warranted, and age-sex specific rates for CO and non-CO suicides were derived.†

*Regional analysis would be difficult since the national grid for gas, initiated on nationalization, was by the 1950s beginning to be effective, so that supplies to a given user might be variably derived from a number of producing centres.

†A compilation of annual suicide rates, 1960-71, by age and sex, for England and Wales and for Scotland, and subdivided into CO and non-CO suicides is available from the author on request.

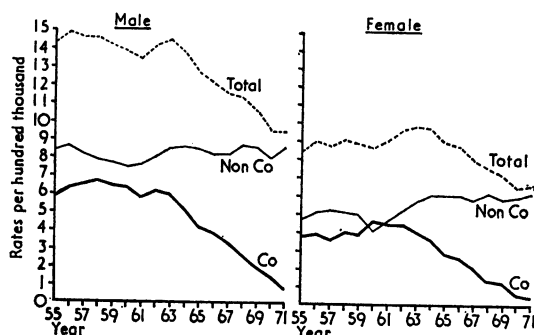


FIG. 4. England and Wales: sex-specific suicide rates by mode of death.

The data were examined first to find a convenient baseline against which recent trends could be examined. Inspection of the rates of suicides for all causes combined, in each age and sex group, showed that for 13* of the 14 age-sex subgroups either 1962 or 1963 represented a peak year. The sum of the rates for these two years (which is of course twice their average rate) was therefore taken as the base for an index of subsequent change. For CO suicides also, these years represented a peak in 12 of the 14 subgroups, but as will be seen, this was not true for 'other suicides'.

*The exception was for females aged 15-24 years, a subgroup on which the rate is often calculated with rather small numbers and which therefore tends to be unstable

For comparison the years 1970 and 1971 were also summed and this value expressed as a percentage of the 1962 plus 1963 rates. The basic data for (a) all suicides, (b) CO suicides, and (c) other suicides are given in Table I. Suicide in men has declined in all age groups, especially the oldest. Suicides specifically due to CO have decreased dramatically in all categories, with a rather more marked decline among the elderly. For suicide due to non-CO methods there is a clear increase in rates for young men (of 33% for the 15-24-year group), little change in the middle aged, and a decline among older people (to 81% in the 75 years and over group). Thus the decrease in CO suicide has been sufficiently large to lower the total suicide rate at all ages, but in doing so it conceals an appreciable increase in young men of suicides by other means; for older men the decline in CO deaths is paralleled by a more modest fall in non-CO deaths.

Fortunately this summary need not be complicated by consideration of the popularity of CO among suicides of different age groups. Analysis shows that for men its proportional use was not systematically affected by age either in 1962-63 or 1970-71.

The situation for females, also shown in Table I, is slightly different. Again the rates for suicide have decreased during the period for all age groups, and again like men, the fall is most noticeable in the elderly. CO deaths have also greatly decreased, more or less uniformly by age. 'Other suicides' again show a marked increase among the youngest,

TABLE I
SUICIDE RATES (PER 100 000) IN ENGLAND AND WALES DUE TO DOMESTIC GAS AND OTHER CAUSES, 1962-63 AND 1970-71, BY AGE AND SEX

Age (years)	All Suicides			CO Only			Other Suicides		
	1962-63 (a)	1970-71 (b)	$\frac{b}{a}$ as %	1962-63 (a)	1970-71 (b)	$\frac{b}{a}$ as %	1962-63 (a)	1970-71 (b)	$\frac{b}{a}$ as %
Males									
15- ..	13.4	11.1	83	6.3	1.6	25	7.1	9.5	133
25- ..	23.3	18.6	80	10.5	1.9	18	12.8	16.5	129
35- ..	31.8	24.0	75	12.2	3.2	26	19.6	20.8	106
45- ..	41.7	28.7	69	16.3	3.9	24	25.4	24.8	98
55- ..	59.6	34.6	58	25.2	3.8	15	34.4	30.8	90
65- ..	68.9	42.9	62	29.2	5.2	18	39.7	37.7	95
75+ ..	82.8	41.9	51	39.1	6.3	16	43.7	35.6	81
All ages ..	28.7	19.0	66	12.2	2.4	20	16.5	16.6	101
Females									
15- ..	5.4	5.1	94	2.8	0.3	11	2.6	4.8	185
25- ..	15.3	9.5	62	7.1	0.6	8	8.2	8.9	109
35- ..	20.0	13.9	70	7.4	0.9	12	12.6	13.0	103
45- ..	31.0	21.1	68	12.9	1.7	13	18.1	19.4	107
55- ..	40.1	26.0	65	17.5	2.7	15	22.6	23.3	103
65- ..	40.4	29.5	73	18.1	3.1	17	22.3	26.4	118
75+ ..	32.6	21.5	66	16.3	1.7	10	16.3	19.8	121
All ages ..	19.6	13.3	68	8.6	1.1	13	11.0	12.2	111

but all the other age groups except one show some increase varying in magnitude from 3% to 21%. Thus, as with males, the CO suicide decline has been great enough to reduce the total suicide rate at all ages, and to mask the rise in suicides by other means, of which the most striking example is provided by young women; their rate, although comparatively low, has increased by 85% (for those aged 15-24 years). Again there is no obvious age-trend of preference for CO as a mode of death among women suicides either in 1962-63 or 1970-71.

THE EIGHTH REVISION OF THE ICD

In 1968 the category AE149 was introduced into the Eighth Revision of the *International Classification of Diseases* for instances where no decision could be reached whether a death had occurred accidentally or by suicide. This change could clearly influence the interpretation of secular trends in suicide rates.

Precisely how these 'undetermined' deaths were classified before 1968 is a tortuous issue, but it is possible that a fall in officially recognized suicides might have occurred subsequently, since marginal cases could then be accommodated under the new rubric. Fig. 1 shows that such a drop did not ensue, while inspection of the data for each age-sex subgroup shows that in 12 of the 14 classes the decrement between 1967 and 1968 was no greater than between other adjacent years in the series.* Thus, for suicide due to all causes the new category had little impact.

When CO suicides are considered separately it emerges again that 12 of the 14 age-sex subgroups showed no obvious change in rates around 1968 although it is interesting that the two exceptions were again males and females aged 15-24 years.† Thus, in general, CO suicide mortality rates have not been significantly affected by the ICD revision.

ACCIDENT MORTALITY

Deaths officially classified as accidents are relevant because such deaths in adults, especially by poisoning, may well be suicides; hence trends in suicide rates require to be interpreted alongside trends in accident mortality. Furthermore, to

anticipate a subsequent discussion, it has been claimed that the decline in accidental deaths from domestic gas provides independent confirmation of the greater safety of detoxified gas supplies.

About half of all accidental deaths result from road accidents, which have not been further considered. Instead, data for two selected causes, namely 'gases and vapours' and 'drugs and medicaments' have been inspected (summarized as two-year totals in Table II). The former shows the now familiar 1962-63 peak followed by a marked reduction, as already noted for CO suicides. Drugs and medicaments, on the other hand, show a progressive rise during the period, again reflecting the trend for non-CO suicides. (The rise in accidental drug deaths has not been due primarily to more accidental poisoning by children.)

Taken together there is an increasing rate up to 1963 and then a decline much as reflected in the 'all causes' suicide rates.‡ It is also evident that 1968 did not mark any abrupt change in the progression.

VALIDITY OF THE TRENDS IN SUICIDE RATES

It appears then that an interpretation of trends of the suicide rates is not likely to be erroneous simply because of changes in the manner of classifying deaths. There have been no compensatory changes; CO suicides and CO accidents have varied in parallel as have non-CO suicides and accidents due to drugs. The introduction of the undetermined category has had no discernible effect on this picture. Misclassification undoubtedly occurs, but the most parsimonious explanation is that it is constant.

SCOTLAND

In Scotland the ascertainment of suicide is carried out by a system very different from that of England and Wales, and the profile of age-sex specific rates is also different.

The recent trends in crude suicide rates for Scotland were illustrated in Fig. 2. Although much flatter than the England and Wales curves, the males again show a 1962-63 peak followed by a slow decline. The female rates, which had accelerated appreciably during the early 1950s, show a diffuse peak between about 1962 and 1965 and only a very modest diminution subsequently. Trends in

*The two exceptions both concern females. The 15-24-year age group fell from 3.4 to 2.5/100 000, a difference of 0.9, while other adjacent years showed a fall of no more than 0.4; however 1967 was unusual in being a peak year for this age group. The second group was the 45-54-year bracket which fell from 12.9 to 11.4; this fall of 1.5 is most nearly approached by a decline of 1.1 (15.7 to 14.6) in 1963/4.

†If the apparent fall in CO suicides in these age groups is partly artefactual then the rise in non-CO suicides, obtained by subtraction, is overestimated. However, an increase in the non-CO suicides was clearly evident before 1968. The youngest age groups might require closer study as they could represent a modification of the general picture.

‡Among males the ratio of selected accidental deaths (gas + drug) to all suicides has varied narrowly between 0.14 and 0.18 over the 12 years, and the two rates correlate at $r = 0.81$. For females the ratio has fluctuated between 0.27 and 0.35, with $r = 0.92$.

TABLE II
ACCIDENTAL DEATH RATES (PER 100 000) FOR 'GASES AND VAPOURS' AND 'DRUGS AND MEDICAMENTS': ENGLAND AND WALES, 1960-71, ALL AGES, BY SEX

Cause of Death	Years					
	1960-61	1962-63	1964-65	1966-67	1968-69	1970-71
Gas and vapour E870-77						
Males	3.1	3.9	2.9	2.5	1.7	1.5
Females	4.0	5.1	3.6	3.0	2.1	1.2
Drugs and medicaments E850-59						
Males	0.7	1.1	1.1	1.3	1.5	1.8
Females	1.0	1.3	1.6	1.9	2.0	2.6
Total						
Males	3.8	5.0	4.0	3.8	3.2	3.3
Females	5.0	6.4	5.2	4.9	4.1	3.8

The figures represent the sum of the annual rates for each pair of years

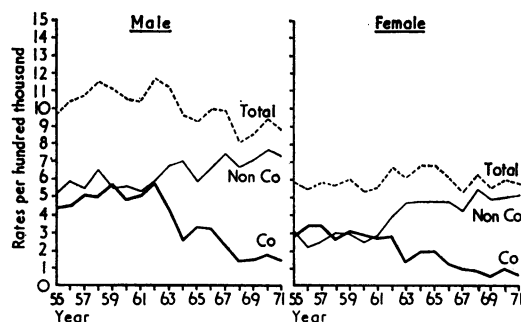


FIG. 5. Scotland: sex-specific suicide rates by mode of death.

crude rates by type of suicide are shown in Fig. 5. They are similar to those already presented for England and Wales.

The Scottish data were subsequently analysed in full following exactly the same procedures as for the England and Wales material. Space precludes presentation here, though the data are available on request. A number of minor differences emerged—chiefly concerning a relatively greater increase in non-CO suicides among young men and middle-aged women than was found for England and Wales—but the overall pattern was the same.

THE DECLINE IN CO SUICIDES

Both regional sets of data suggest that there has been a decline in CO suicides affecting both sexes and all age groups dating from about the time when the CO content of domestic gas began to fall. A direct causal link ascribing the former to the latter seems highly likely.

However this conclusion can be opposed by a counter-argument which hinges not upon the nature

of the *agent* but upon the characteristics of the *persons* affected. If changes in the toxicity of gas were the sole explanation for the fall in the rates then it would be expected that the ratio of CO suicides to other types of suicide would show a similar fall in all subgroups of the population. If, however, the decline in CO deaths was found to be confined to only one group of individuals then the primary explanation could not lie in the nature of the gas itself.

The England and Wales data suggest that women have shown a disproportionate decline (in the ratio of CO to other forms of suicide) but this finding is not confirmed by the Scottish data and no firm evidence can be adduced for any age-sex subgroup constituting an exception to the general pattern.

There are other sources of data to be considered. The first is a series of 'suspicious' deaths studied by Ovenstone in Edinburgh (Ovenstone, 1972; Ovenstone and Kreitman, 1974). The study reports on 106 suicides, judged as such by psychiatrists, including 16 who died by domestic gas poisoning. The latter have been compared with the remaining 90 on a large number of variables and found not to differ on age, sex, social class, area of residence, or civil state. However, three significant differences ($P < 0.05$ in each instance) were found: the CO suicides had less often been living with their close family, had had less contact with a general practitioner in the three months before their death, and similarly had had less contact in the period three to six months before their death.

The second source of data came from Chichester, Sussex, and have been analysed by Dr Brian Barraclough. Of 100 officially recorded suicides in Sussex (Barraclough *et al.*, 1974) 15 were due to domestic gas poisoning, an identical proportion to the Edinburgh series. Exact comparisons between

the two studies were not possible except for frequency of contact with the general practitioner during the three months before death. There was a significant lack of consultation in the proportion of CO suicides, shown in Table III. There is thus confirmation that the CO suicides differed in at least this one respect from other suicides.

If these two series are accepted as representative it would be possible to argue that improved general practitioner cover or a greater frequency of contact with practitioners during the period in question could explain the decline in CO suicides as readily as changes in the type of gas supplied. If the size of the average GP's list is any guide, this alternative notion has no support: in England and Wales the average list increased from 2289 in 1960 to 2478 in 1970, with corresponding figures of 1986 and 2086 for Scotland (*Journal of the Royal College of General Practitioners*, 1973). Data on the consulting habits of suicides in the early 1960s do not appear to be available. In brief, the argument has no support. Nevertheless it is worth recording that CO suicides evidently do differ from others in their pre-terminal medical care.

OTHER CONSIDERATIONS

If a direct causal connexion between changes in the gas supplied and the fall in CO suicide rate is accepted then three further considerations emerge. One has been raised by Bagley (1973)

who argued that parallel with a fall in lethal CO poisoning there should have been an increase in non-lethal CO intoxication at medical centres treating parasuicide ('attempted suicide'), such patients being essentially failed suicides. This argument is ill-founded; if every suicide in the country, due to whatever cause, were to be snatched from the jaws of death and reclassified as a parasuicide the proportional increase in parasuicides would be so small as to be barely detectable. But in fact the numbers of deliberate CO intoxications seen at hospitals has actually decreased markedly. Bagley's own data have been questioned but the figures relating to the Regional Poisoning Treatment Centre at Edinburgh indicate the same trend (Table IV).

Furthermore, if only those cases in which CO was the primary poison are considered, it appears that the most marked decline has been among patients with deeper levels of unconsciousness on admission (Table V).

These facts can probably be reconciled with the main argument, for even if similar numbers of people were poisoning themselves with gas, modern supplies may now be considered so safe that deep coma is rarely attained and even lesser degrees of unconsciousness would be uncommon. While a 1% mixture of CO may be lethal, such a concentration is unlikely to be achieved, except by the unusually determined. In ordinary cases, little or no

TABLE III
GENERAL PRACTITIONER CONTACT DURING THREE MONTHS BEFORE SUICIDE
(EXCLUDING 'NOT APPLICABLE' CASES)

Contacts with GP	Edinburgh Series			Chichester Series		
	CO Suicides	Other Suicides	Total	CO Suicides	Other Suicides	Total
None	8	19	27	7	16	23
One or more	8	66	74	8	65	73
Total	16	85	101	15	81	96

$$\chi^2 \text{ (Yates)} = 5.24$$

$$df = 1, P < 0.05$$

$$\chi^2 \text{ (Yates)} = 5.02$$

$$df = 1, P < 0.05$$

TABLE IV
CARBON MONOXIDE IN ACUTE POISONING ADMISSIONS TO THE EDINBURGH REGIONAL POISONING
TREATMENT CENTRE 1968-73

Year	CO as		Total	All Admissions	% CO
	Principal Poison	Associated Poison			
1968-69	105	1	106	2032	5.2
1970-71	84	12	96	2689	3.6
1972-73	52	10	62	3285	1.9

TABLE V
COMA LEVEL IN ADMISSIONS WITH PRIMARY CO
POISONING: EDINBURGH REGIONAL POISONING
TREATMENT CENTRE, 1968-73

Years	Grades 0-2 (Mild)	Grades 3-4 (Severe)	% Severe All
1968-69 ..	82	23	22
1969-71 ..	71	13	16
1972-73 ..	46	6	12
Percentage 1972-73 ..	56	26	
1968-69 ..			

malaise would be experienced. Since general practitioners and others are influenced by the actual or anticipated coma level in obtaining emergency aid (Kennedy and Kreitman, 1973), fewer hospital referrals would ensue.

Secondly, there is the significance of the decline in accidental gas deaths, which can be construed as independent evidence of a greater safety of current gas supplies. That the gas is less toxic is not in doubt, but more questionable is the meaning of the decline in accidental gas deaths. It seems very likely that substantial numbers of such deaths are actually suicides, so that the two seemingly separate sets of data are in fact related to the one phenomenon; indeed, the similarity of the trends is a powerful point in favour of their identity. It is suggested, therefore, that the argument from accident statistics should be set aside.

Finally, there is the question of a contribution of other agencies such as the Telephone Samaritans, general practitioners, or the psychiatric services to the decline in suicide rates. The arguments which have been advanced on behalf of each can scarcely be detailed here, but it seems extraordinarily unlikely that any of them could have had an effect which is specific for suicide due to carbon monoxide and not other poisons. Indeed, if the CO deaths are subtracted there is no 'decline' to explain; on the contrary, the rates are increasing, although this does not mean, of course, that these agencies and services have no effect at all.

CONCLUSION

Despite a minor reservation based on the GP consulting habits of CO suicides, the close temporal association between the declining CO content of domestic gas and the fall in suicides due to this agent while those from other causes have followed a quite different trend, lead to the conclusion that there is a direct causal relationship between the two phenomena.

SOME IMPLICATIONS

There are three main implications that arise from this conclusion. First, studies of longitudinal trends of suicide must henceforth distinguish between CO and other forms. Such investigations are still needed. Far from any improvement the non-CO suicide rate has been shown to be increasing, especially in Scotland, among women in both regions, and among the young and middle-aged.

Secondly, there are intriguing differences between different demographic subgroups in how the trends in the two agent-defined groups of suicide are related. Thus among the elderly men, especially those of England and Wales, both rates have declined and the group as a whole has become much less suicide-prone. Among men below 45 years of age in the same region a fall in CO suicides has been counteracted by an increase in other forms. How is this 'compensation' to be understood? Does it reflect the emergence of a new group of suicides, perhaps drug addicts and alcoholics, or does it reflect a switch to an alternative mode of death by individuals similar to those who have always been at risk but who have tried but failed to kill themselves with coal gas (or have heard that it is not efficacious)?

Lastly, and perhaps implicit in the preceding point, is the overriding question of how the removal of a single agent of self-destruction can have had such far-reaching consequences. There is no shortage of exits from this life; it would seem that anyone bent on self-destruction must eventually succeed, yet it is also quite possible, given the ambivalence (or multivalence) of many suicides, that a failed attempt serves as a catharsis leading to profound psychological change. For others it may be that the scenario of suicide specifies the use of a particular method, and that if this is not available actual suicide is then less likely. Virtually nothing is known about such questions.

Sincere appreciation is expressed to staff of the Gas Standards Branch, Department of Energy, Leicester, and to the Scottish Gas Board for invaluable data concerning gas supplies; to Dr Henry Matthew and Dr C. Swainson of the Regional Poisoning Treatment Centre, Edinburgh, for information on recent trends in CO poisonings; to Miss O. Ross for assistance with data analysis, and to other colleagues for many helpful comments.

Requests for reprints: N. Kreitman, MD, MRCP, FRCPsych, Director, MRC Unit for Epidemiological Studies in Psychiatry, Royal Edinburgh Hospital, Morningside Park, Edinburgh EH10 5HF.

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